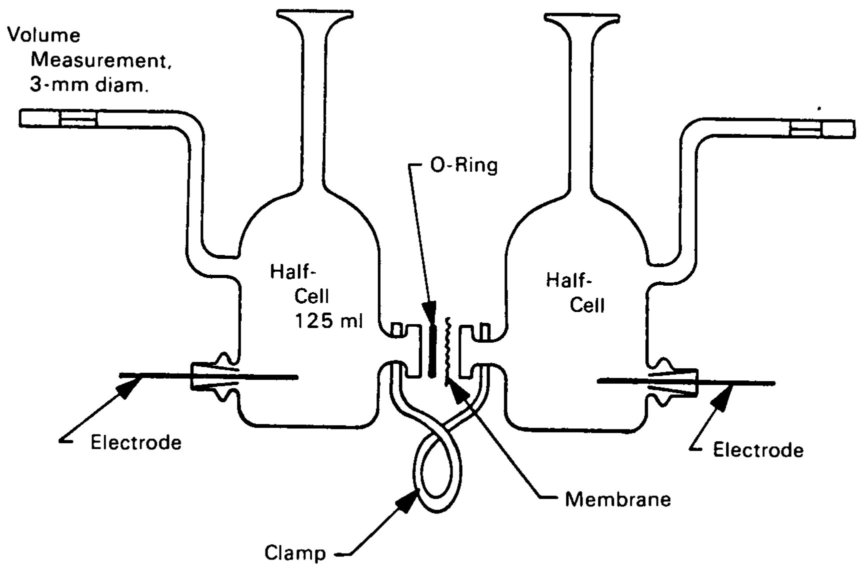
NASA TECH BRIEF

Ionene Membrane Battery Separator



Transport Cells for Ionene Membrane Tests

The problem:

Prepare insoluble membranes from soluble polyelectrolyte compositions termed "ionenes" and study the ionic transport characteristics of these membranes for possible application in a battery separator. Incorporated along the hydrocarbon backbone in ionenes are uniformly distributed positive quaternary ammonium ionic groups whose charge density can be varied systematically to assess the effect on transport coefficients.

Various types of batteries require separator membranes which allow passage of smaller ions but prevent migration of heavy metal ions. Effectiveness of the thin film of separator membrane essentially determines battery lifetime. There is a need for separators that are completely effective in avoiding internal short circuiting of a battery.

The solution:

Membranes are prepared from a copolymer designated as a 6, 6-ionene, polyvinyl alcohol substrate, and tetrachloro-o-benzoquinone (a radical initiator). The ionic transport characteristics of these membranes are studied in transport cells.

How it's done:

N, N, N', N'-tetramethylhexanediame and 1, 6-dibromohexane are reacted on a 1:1 gram molecular weight basis to synthesize a copolymer designated as 6, 6-ionene. This copolymer is weighed and added to a polyvinyl alcohol aqueous solution and tetrachloro-o-benzoquinone in different proportions. The polyvinyl alcohol and tetrachloro-o-benzoquinone weight ratio are maintained at 100:1. Water is added as needed.

(continued overleaf)

The water mixture is shaken and cast the next day onto glass slides. After allowing the water to evaporate, the films are later heated to 100°C for one hour. These membranes are stored in petri dishes.

The drawing shows transport cells for ionene membrane tests. These cells are fabricated from Pyrex glass. Holding the two half-cells is a glass joint which has a grooved flange to permit installation of an O-ring. The membrane is mounted on the flange of one cell with the O-ring preinstalled. Then the flange from the other cell is brought in contact with the membrane and the assembly clamped. The horizontal arms with a 3-mm bore diameter are used for volume measurement, which is good to $\pm 14\ \mu l$ with a volume of about 125 ml per cell. Glass joints are included to permit insertion of platinum electrodes.

Membranes, water-prewetted or dry, are mounted first; platinum electrodes are inserted next; then the cells are filled with their respective bathing media. When the media contacts the membrane, an electrical timer is activated. The transport apparatus is placed in an ultrasonic cleaner and vibrated for two minutes to remove any entrapped gases. The cells are then transferred to a bench where an ac impedance bridge for resistance and a high-impedance dc millivoltmeter are connected to each electrode. A regulated dc power supply is used. The millivoltmeter which continuously monitors the potential difference across the membrane is assumed not to draw current from the system. Only when the membrane resistance is measured is the bridge activated. It is energized by a 400 mV 1000 Hz internal source. Aliquots of $50\ \mu l$ are removed periodically from each cell.

Thicknesses of membranes while dry, in water, and in salt solution are measured to $\pm 31\ \mu m$ with a calibrated filar eyepiece and a stereomicroscope. For the analysis of the transport experiments, the thickness is taken to be the average dimension in water and salt solution.

At different intervals of time the volume difference of each cell, ac resistance at 1000 Hz potential difference, and aliquots from each cell are obtained. The potential observed is that generated by the two cells which act as concentration half-cells.

When the chemical analyses are complete and the concentrations are available, the presence or absence of preferred ionic transport will be determined.

Notes:

1. Adding tetrachloro-o-benzoquinone to 6, 6-ionene in a polyvinyl alcohol substrate achieves the requisite degree of polymer crosslinking and, hence, the necessary strength. The strengthened insoluble product continues to have attractive permeability characteristics. Method of synthesis and final membranes are believed to be novel.
2. This information should be of interest to designers, manufacturers, and users of batteries.
3. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10501

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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